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ASSESSMENT OF LEAF AREA INDEX (LAI) SEASONAL DYNAMICS IN YOUNG PLANTATIONS OF *SORBUS INTERMEDIA* (EHRH.) PERS., 1806 FOR AN URBAN ECOSYSTEM

Abstract. *A complete seasonal time series of effective leaf area index (LAI 4 Ring) was obtained for 25 young individuals of Sorbus intermedia (Ehrh.) Pers., 1806 in an urban botanical garden using digital hemispherical photography (DHP) throughout the 2025 growing season (May–October). The mean seasonal effective LAI was 1.51 ± 0.31 (range 0.66–3.85). Repeated Measures ANOVA confirmed highly significant seasonal changes ($F = 31.90$; $p < 10^{-16}$). The dataset provides validated ground truth data for urban ecosystem modelling and remote sensing calibration.*
Keywords: leaf area index (LAI); digital hemispherical photography (DHP); *Sorbus intermedia*; urban ecosystem; phenology; seasonal dynamics; Gap Light Analyzer.

The leaf area index (LAI) is a fundamental biophysical parameter defined as the total one-sided leaf area per unit ground surface area ($m^2\ m^{-2}$) [1]. LAI plays a critical role in characterizing vegetation canopies[2], modelling carbon-cycle processes and ecosystem water exchange. The concept was introduced by Watson [3] and refined for non-flat leaves by Chen & Black [4]. LAI values are essential for understanding developmental patterns of urban plantations, particularly introduced species such as *Sorbus intermedia* (Ehrh.) Pers., 1806, which exhibits tolerance to urban stressors. The objective of this study was to acquire a high-quality ground-based time series of effective LAI for 25 trees throughout the 2025 growing season and to statistically validate its quality and consistency [5].

The study was conducted in the Botanical Garden of Oles Honchar Dnipro National University (Dnipro, Ukraine). Observations spanned the entire 2025 growing season (May–October) on 25 individuals of *S. intermedia* of identical age (12 years) with similar morphological characteristics.

Effective LAI was measured using Digital Hemispherical Photography (DHP) with a 180° fisheye lens on a smartphone (iPhone 12). Fourteen measurement campaigns were conducted from May 30 to October 3, 2025, with photographs taken vertically upward from ground level beneath each tree canopy. Photographs were processed using Gap Light Analyzer (GLA) v. 2.0 [6]. The effective LAI 4 Ring value (zenith angles 0–60°) was used. Statistical analysis included Repeated Measures ANOVA, pairwise Pearson correlation, and coefficient of variation (CV) calculations performed in Python 3.11 (pandas, statsmodels).

Seasonal dynamics: The seasonal mean effective LAI 4 Ring across 25 trees was 1.51 ± 0.31 (min. 0.66 – max. 3.85). Maximum canopy development was recorded at the season start (May 30: 2.27 ± 0.69), a plateau was maintained through June–July

(LAI ≈ 1.4–1.7), followed by a decline through August–October reaching a minimum on September 26 (1.07 ± 0.29) (Fig. 1).

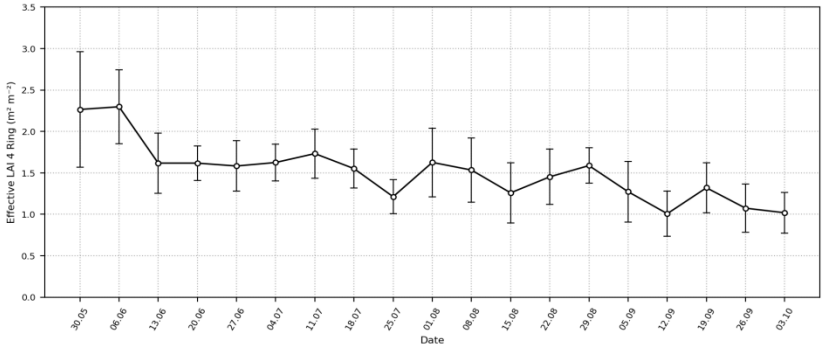

Fig. 1. Seasonal dynamics of effective LAI 4 Ring (mean ±SD) for 25 trees of *S. intermedia*, 2025.

Variability: Spatial variability was highest at season start (CV = 28.7%, May 30) due to leaf unfolding asynchrony and lowest during peak development (CV = 13.8%, July 4). Mean pairwise Pearson correlation r = 0.55 (range −0.83–0.98) indicates moderate phenological synchrony. Individual trees showed pronounced differences: highest seasonal means: S3 – 2.02, S25 – 1.94, S13 – 1.93; lowest: S22 – 0.97, S16 – 1.10, S24 – 1.23 (Table 1).

Table 1

Main statistical indicators of selected trees (effective LAI 4 Ring)

Tree	Mean LAI 4R	SD	CV, %	Min	Max	Range
S3	2.02	0.61	30.0	1.40	3.85	2.45
S13	1.93	0.57	29.5	1.06	3.10	2.04
S25	1.94	0.15	7.5	1.62	2.20	0.58
S16	1.10	0.30	27.6	0.73	1.58	0.85
S22	0.97	0.24	24.9	0.66	1.56	0.90
S24	1.23	0.33	26.5	0.72	1.73	1.01

Repeated Measures ANOVA confirmed highly significant seasonal changes ($F = 31.90$; $p < 10^{-16}$). No anomalies were detected after interpolation; inter-tree variability is biologically justified (CV 13.8–28.7%).

A complete, statistically validated time series of effective LAI was obtained for young *S. intermedia* plantations under urban conditions. Values (1.51 ± 0.31) fall within the lower range typical for temperate urban broadleaf plantations, explained by tree age (12

years) and urban stressors. The atypical seasonal trajectory (early May–June peak, gradual June–July plateau, August–October decline) distinguishes urban *S. intermedia* from mature natural stands. Moderate phenological synchrony ($r = 0.55$) indicates meteorological control of phenology combined with individual tree and microsite influences. The dataset (25 trees × 19 dates) serves as ground truth for remote sensing validation and urban ecosystem modelling, contributing to evidence-based green infrastructure planning.

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